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CLAIMS

1.   A method of performing spatial processing in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

processing a first transmission received via a first link to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link; and

performing spatial processing for a second transmission with the at least one eigenvector prior to transmission over the second link.

2.   The method of claim 1, further comprising:

performing spatial processing on a third transmission received via the first link with the at least one eigenvector to recover data symbols for the third transmission.

3.   The method of claim 1, wherein the first transmission is a steered pilot received on at least one eigenmode of a MIMO channel for the first link.

4.   The method of claim 1, wherein the first transmission is a MIMO pilot comprised of a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

5.   The method of claim 4, wherein the processing a first transmission includes

obtaining a channel response estimate for the first link based on the MIMO pilot, and

decomposing the channel response estimate to obtain a plurality of eigenvectors usable for spatial processing for the first and second links.

6.   The method of claim 5, wherein the channel response estimate for the first link is decomposed using singular value decomposition.

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7.   The method of claim 4, further comprising:

performing spatial processing on pilot symbols with the at least one eigenvector to generate a steered pilot for transmission on at least one eigenmode of a MIMO channel for the second link.

8.   The method of claim 1, wherein the second transmission is spatially processed with one eigenvector for transmission on one eigenmode of a MIMO channel for the second link.

9.   The method of claim 1, wherein the second transmission is spatially processed with a normalized eigenvector for transmission on one eigenmode of a MIMO channel for the second link, the normalized eigenvector including a plurality of elements having same magnitude.

10.   The method of claim 1, wherein the first transmission is a steered pilot generated with a normalized eigenvector for one eigenmode of a MIMO channel for the first link, the normalized eigenvector including a plurality of elements having same magnitude, and wherein one eigenvector usable for spatial processing for the first and second links is obtained.

11.   The method of claim 1, further comprising:

calibrating the first and second links such that a channel response estimate for the first link is reciprocal of a channel response estimate for the second link.

12.   The method of claim 11, wherein the calibrating includes

obtaining correction factors for the first link based on the channel response estimates for the first and second links, and

obtaining correction factors for the second link based on the channel response estimates for the first and second links.

13.   The method of claim 1, wherein the TDD MIMO communication system utilizes orthogonal frequency division multiplexing (OFDM), and wherein the

processing for the first transmission and the spatial processing for the second transmission are performed for each of a plurality of subbands.

14.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

means for processing a first transmission received via a first link to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link; and

means for performing spatial processing for a second transmission with the at least one eigenvector prior to transmission over the second link.

15.   The apparatus of claim 14, further comprising:

means for performing spatial processing on a third transmission received via the first link with the at least one eigenvector to recover data symbols for the third transmission.

16.   The apparatus of claim 14, wherein the first transmission is a steered pilot received on at least one eigenmode of a MIMO channel for the first link.

17.   The apparatus of claim 14, wherein the first transmission is a MIMO pilot comprised of a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

18.   The apparatus of claim 17, further comprising:

means for obtaining a channel response estimate for the first link based on the MIMO pilot; and

means for decomposing the channel response estimate to obtain a plurality of eigenvectors usable for spatial processing for the first and second links.

19.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

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a controller operative to process a first transmission received via a first link to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link; and

a transmit spatial processor operative to perform spatial processing for a second transmission with the at least one eigenvector prior to transmission over the second link.

20.   The apparatus of claim 19, further comprising:

a receive spatial processor operative to perform spatial processing on a third transmission received via the first link with the at least one eigenvector to recover data symbols for the third transmission.

21.   The apparatus of claim 19, wherein the first transmission is a steered pilot received on at least one eigenmode of a MIMO channel for the first link.

22.   The apparatus of claim 19, wherein the first transmission is a MIMO pilot comprised of a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

23.   The apparatus of claim 22, wherein the controller is further operative to obtain a channel response estimate for the first link based on the MIMO pilot and to decompose the channel response estimate to obtain a plurality of eigenvectors usable for spatial processing for the first and second links.

24.   A method of performing spatial processing in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

processing a MIMO pilot received via a first link to obtain a plurality of eigenvectors usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas,

and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot;

performing spatial processing on a first data transmission received via the first link with the plurality of eigenvectors to recover data symbols for the first data transmission; and

performing spatial processing for a second data transmission with the plurality of eigenvectors prior to transmission over the second link.

25.   The method of claim 24, further comprising:

performing spatial processing on pilot symbols with at least one of the eigenvectors to generate a steered pilot for transmission on at least one eigenmode of a MIMO channel for the second link.

26.   The method of claim 24, further comprising:

performing calibration to obtain correction factors; and

scaling the second data transmission with the correction factors prior to transmission over the second link.

27.   The method of claim 24, wherein the TDD MIMO communication system utilizes orthogonal frequency division multiplexing (OFDM), and wherein the spatial processing is performed for each of a plurality of subbands.

28.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

means for processing a MIMO pilot received via a first link to obtain a plurality of eigenvectors usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot;

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means for performing spatial processing on a first data transmission received via the first link with the plurality of eigenvectors to recover data symbols for the first data transmission; and

means for performing spatial processing for a second data transmission with the plurality of eigenvectors prior to transmission over the second link.

29.   The apparatus of claim 28, further comprising:

means for performing spatial processing on pilot symbols with at least one of the eigenvectors to generate a steered pilot for transmission on at least one eigenmode of a MIMO channel for the second link.

30.   The apparatus of claim 28, further comprising:

means for performing calibration to obtain correction factors; and

means for scaling the second data transmission with the correction factors prior to transmission over the second link.

31.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

a controller operative to process a MIMO pilot received via a first link to obtain a plurality of eigenvectors usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot;

a receive spatial processing operative to perform spatial processing on a first data transmission received via the first link with the plurality of eigenvectors to recover data symbols for the first data transmission; and

a transmit spatial processor operative to perform spatial processing for a second data transmission with the plurality of eigenvectors prior to transmission over the second link

32.   The apparatus of claim 31, wherein the transmit spatial processor is further operative to perform spatial processing on pilot symbols with at least one of the eigenvectors to generate a steered pilot for transmission on at least one eigenmode of a MIMO channel for the second link.

33.   The apparatus of claim 31, wherein the controller is further operative to perform calibration to obtain correction factors, and wherein the transmit spatial processor is further operative to scale the second data transmission with the correction factors prior to transmission over the second link.

34.   A method of performing spatial processing in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

processing a steered pilot received via at least one eigenmode of a MIMO channel for a first link to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link;

performing spatial processing on a first data transmission received via the first link with the at least one eigenvector; and

performing spatial processing for a second data transmission with the at least one eigenvector prior to transmission over the second link.

35.   The method of claim 34, further comprising:

generating a MIMO pilot for transmission over the second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

36.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

means for processing a steered pilot received via at least one eigenmode of a MIMO channel for a first link to obtain at least one eigenvector usable for spatial

processing for both data transmission received via the first link and data transmission sent via a second link;

means for performing spatial processing on a first data transmission received via the first link with the at least one eigenvector; and

means for performing spatial processing for a second data transmission with the at least one eigenvector prior to transmission over the second link.

37.   The apparatus of claim 36, further comprising:

means for generating a MIMO pilot for transmission over the second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

38.   An apparatus in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

a controller operative to process a steered pilot received via at least one eigenmode of a MIMO channel for a first link to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link;

a receive spatial processor operative to perform spatial processing on a first data transmission received via the first link with the at least one eigenvector; and

a transmit spatial processor operative to perform spatial processing for a second data transmission with the at least one eigenvector prior to transmission over the second link.

39.   The apparatus of claim 38, wherein the transmit spatial processor is further operative to generate a MIMO pilot for transmission over the second link, wherein the MIMO pilot comprises a plurality of pilot transmissions sent from a plurality of transmit antennas, and wherein the pilot transmission from each transmit antenna is identifiable by a receiver of the MIMO pilot.

40. A method of performing spatial processing in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

performing spatial processing on pilot symbols with a normalized eigenvector for one eigenmode of a MIMO channel to generate a first steered pilot for transmission via the one eigenmode of the MIMO channel, the normalized eigenvector including a plurality of elements having same magnitude; and

performing spatial processing on data symbols with the normalized eigenvector prior to transmission on the one eigenmode of the MIMO channel.

41. The method of claim 40, further comprising:

performing spatial processing on pilot symbols with an unnormalized eigenvector for the one eigenmode to generate a second steered pilot for transmission via the one eigenmode of the MIMO channel.

42. A method of performing spatial processing in a wireless time division duplexed (TDD) multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) communication system, comprising:

processing a first transmission received via a first link to obtain a matrix of eigenvectors for each of a plurality of subbands, wherein a plurality of matrices of eigenvectors are obtained for the plurality of subbands and are usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link; and

performing spatial processing for a second transmission with the plurality of matrices of eigenvectors prior to transmission over the second link.

43. The method of claim 42, further comprising:

ordering the eigenvectors in each matrix based on channel gains associated with the eigenvectors.

44.   The method of claim 43, wherein the second transmission is sent on at least one wideband eigenmode, each wideband eigenmode associated with a set of eigenvectors in the plurality of matrices having same order after the ordering.

45.   A method of estimating a wireless channel in a time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

processing a pilot transmission received via a first link to obtain a channel response estimate for the first link; and

decomposing the channel response estimate to obtain a matrix of eigenvectors usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link.

46.   A method of estimating a wireless channel in a time division duplexed (TDD) multiple-input multiple-output (MIMO) communication system, comprising:

receiving a steered pilot on at least one eigenmode of a MIMO channel for a first link; and

processing the received steered pilot to obtain at least one eigenvector usable for spatial processing for both data transmission received via the first link and data transmission sent via a second link.

47.   The method of claim 46, wherein the processing includes

demodulating the received steered pilot to remove modulation due to pilot symbols used to generate the steered pilot, and

processing the demodulated steered pilot to obtain the at least one eigenvector.

48.   The method of claim 46, wherein the at least one eigenvector is obtained based on a minimum mean square error (MMSE) technique.

49.   The method of claim 46, wherein a plurality of eigenvectors are obtained and are forced to be orthogonal to one another.

50.   A method for performing data processing in a wireless communication system including an access point and a user terminal, the method comprising:

calibrating one or more communication links including a first link and a second link between the access point and the user terminal to form a calibrated first link and a calibrated second link;

obtaining a channel response estimate for the calibrated first link based on one or more pilots transmitted on the calibrated first link; and

decomposing the channel response estimate to obtain one or more eigenvectors usable for spatial processing of the one or more communication links.

51.   The method of claim 50 wherein calibrating comprises:

determining one or more sets of correction factors based on estimates of channel responses for the one or more communication links; and

applying the one or more sets of correction factors to the first and second links to form the calibrated first and second links.

52.   The method of claim 50 further comprising:

performing spatial processing for data transmissions on the first and second links using the one or more eigenvectors obtained from decomposing the channel response estimate for the calibrated first link.

53.   The method of claim 52 wherein performing spatial processing comprises:

transmitting a steered reference on the second link using the one or more eigenvectors.

54.   The method of claim 53 further comprising:

performing spatial processing on or more pilot symbols with the one or more eigenvectors to generate the steered reference.

55.   An apparatus for performing data processing in a wireless communication system including an access point and a user terminal, the apparatus comprising:

means for calibrating one or more communication links including a first link and a second link between the access point and the user terminal to form a calibrated first link and a calibrated second link;

means for obtaining a channel response estimate for the calibrated first link based on one or more pilots transmitted on the calibrated first link; and

means for decomposing the channel response estimate to obtain one or more eigenvectors usable for spatial processing of the one or more communication links.

56.   The apparatus of claim 55 wherein calibrating comprises:

means for determining one or more sets of correction factors based on estimates of channel responses for the one or more communication links; and

means for applying the one or more sets of correction factors to the first and second links to form the calibrated first and second links.

57.   The apparatus of claim 55 further comprising:

performing spatial processing for data transmissions on the first and second links using the one or more eigenvectors obtained from decomposing the channel response estimate for the calibrated first link.

58.   The apparatus of claim 57 wherein performing spatial processing comprises:

transmitting a steered reference on the second link using the one or more eigenvectors.

59.   The apparatus of claim 58 further comprising:

performing spatial processing on or more pilot symbols with the one or more eigenvectors to generate the steered reference.